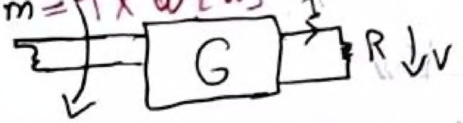
#KoJoK

Dc _ Machine

- Dc generators
- Dc Motors

$P_m = T \times W\ [W]$

$P_G = V \times I = I^2 R = \frac{V^2}{R}$

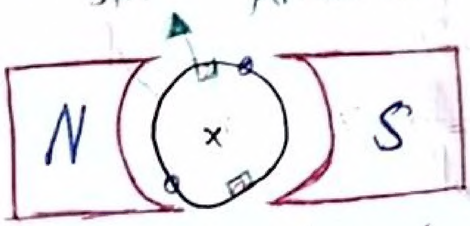


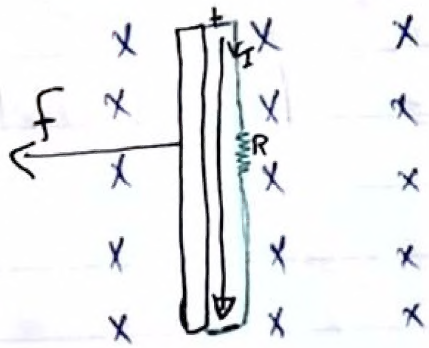
* كيف يتم الحصول على الحركة

1) fuel 2) Wator (hydro) 3) Steam 4) wind (Prime mover)

Genrator action

Slot Armature → P, V, I





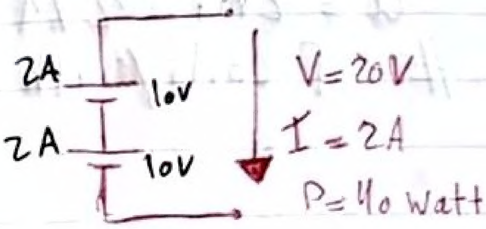
Single layer

\# of Condnctor $Z = 2CN$ → # of turns

\# of coil

- 24 slots
  - Single layer
    # of Coills = 12
  - double layer
    # of Coils = 24

double layer



* Armature widing Connection:

1) lap winding: $a = mP$

P: # of Poles
m: smplex = 1
double = 2

2) wave winding: $a = 2m$

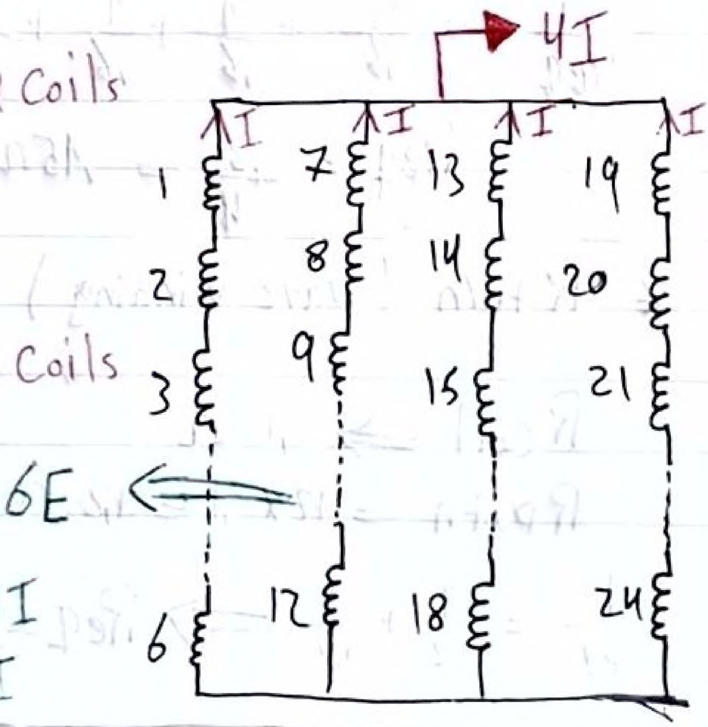
Ex: DC genrator with 48 slots, single layer, P = 4

1) Draw the armature winding in Case smplex lap winding

$\# \text{ of Coils} = \frac{1}{2} \times 48 = 24 \text{ Coils}$

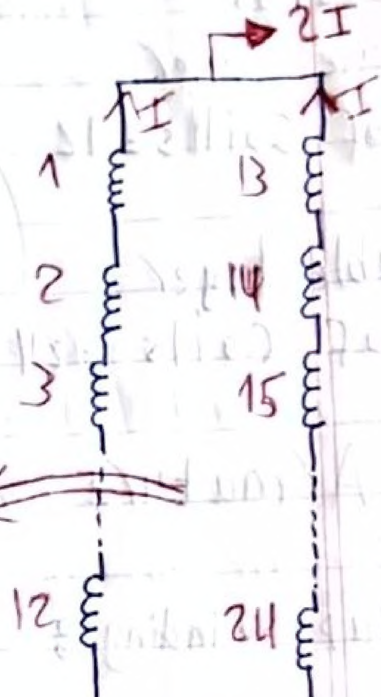
$a = mP = 1 \times 4 = 4$

$\# \text{ of Coils/path} = \frac{24}{4} = 6 \text{ Coils}$



$P = 6E \times 4I$
$= 24EI$

2) Draw the armatur winding in case smplex wave winding



# of Coils = 24

$a = 2m = 2 \times 1 = 2$

# of coils / path = 24/2 = 12

12 E

$P = 12 E \times 2I$

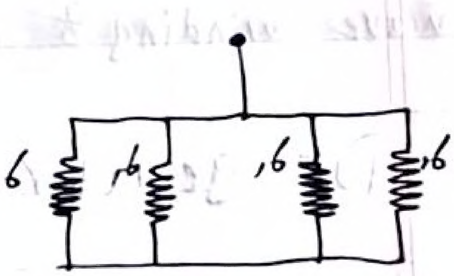
$= 24 EI$

* R turn (lap winding) → ,01 Ω

# of for each Coil = 10

$R_{coil} = ,01 \times 10 = ,1\ \Omega$

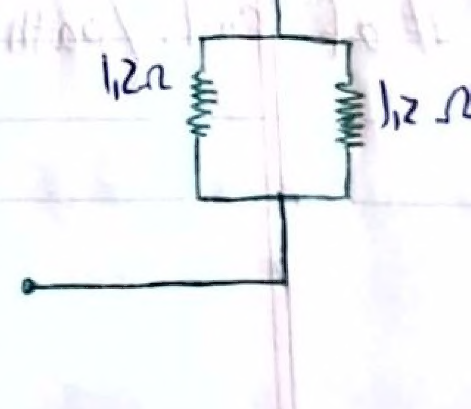
$R_{Path} = 6 \times ,1 = ,6\ \Omega$



$$\frac{1}{R_{eq}} = \frac{1}{,6} + \frac{1}{,6} + \frac{1}{,6} + \frac{1}{,6}$$

$$R_{eq} = \frac{,6}{4} = ,15\Omega$$

* R turn (wave winding) :



$R_{coil} \Rightarrow ,1\ \Omega$

$R_{Path} = 12 \times ,1 = 1,2\ \Omega$

$$\frac{1}{R_{eq}} = \frac{1}{1,2} + \frac{1}{1,2} \Longrightarrow R_{eq} = \frac{1,2}{2} = ,6\ \Omega$$

* Req for armature winding

Armature resistance (R_A)

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* equivelant circuit of DC generater

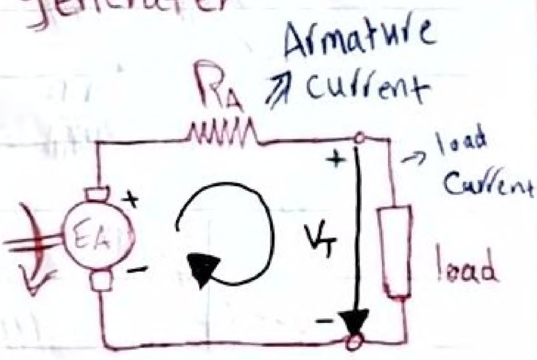
$$E_A = K \phi \omega$$

ϕ : flux [Wb] Vs

ω : speed [rad/sec]

K : machine constant

$$K = \frac{Z * P}{2\pi * a}$$



* حتى نخلي V_T ثابتة
لازم نغير بـ E_A

$\overset{V_T}{100} = 120 - 20$, $\overset{V_T}{100} = \overset{E_A}{105} - \overset{I_AR_A}{5}$

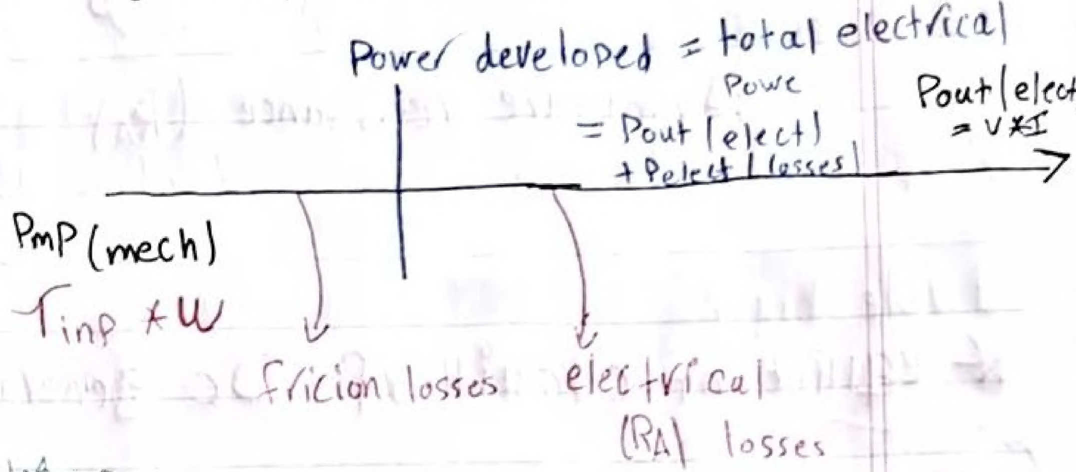
$Z = 2CN$, P = # of Poles , a = mp or 2m حسب النوع

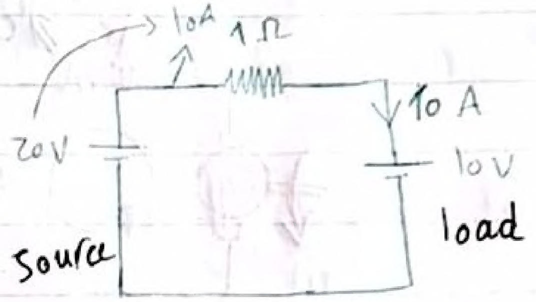
$$-E_A + I_A R_A + V_T = 0$$

$$V_T = E_A - I_A R_A$$

$$VR = \frac{E_A - V_T}{V_T} * 100\%$$

Power flow diagram of DC genrator





$losses = 10^2 \times 1 = 100\,W$

$Pout = 10 \times 10 = 100\,W$

$Pmp = 20 \times 10 = 200\,watt$

induced Torque , W

$$T_{ind} = \frac{P_{dev}}{W}$$

Input Tourque

$$T_{inp} > T_{ind}$$

$$T_{inp} = T_{app} = \frac{P_{inp}}{W}$$

$$P_{inp} = P_{dev} + P_f \; / W$$

$$T_{inp} = T_{ind} + \left(\frac{P_f}{W}\right)$$

Ex:

* DC genrator, P = 4, 120 slotts, each coil consists 10 turns, smplex lap windin, turn resistanc = ,01 Ω

1) Detrmine armature resistance (R_A)

# of coils ⇒ 60 coil

$a = mP = 1 \times 4 = 4$

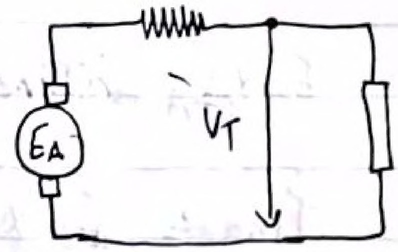
# of coils/path = 60/4 = 15

$R_{coil} = 10 * ,01 = ,1\ \Omega$

$R_{path} = ,1 \times 15 = 1,5\ \Omega$

$$\frac{1}{R_{eq}} = \frac{4}{1,5} \Longrightarrow R_A = ,375\ \Omega$$

2) if the fulx = ,02 wb, speed = 1200 rpm determine no load voltage



$I_A = 0$ at no load

$$V_T = E_A - \cancel{I_A R_A}^{\,0}$$

$$V_T = E_A$$

$$E_A = K\Phi * \omega = \frac{ZP}{2\pi a} * \Phi \times \overset{\text{speed}}{n} * \frac{2\pi}{60}$$

$Z = 2CN = 2 \times 60 \times 10 = 1200$ Conductor

$$= \frac{\overset{600}{\cancel{1200}} \times \cancel{4}}{\cancel{2}(3.14)\cancel{4}} * ,2 \times \overset{200}{\cancel{1200}} \times \frac{2\cancel{\pi}}{\cancel{60}} = 480\ V$$

3) Detrmine the speed rquired for the genrator to supply 20 KW, $V_T = 500V$, $\phi = ,02$ wb

$$I = \frac{20000}{500} = 40 \text{ A}$$

$$E_A = V_T + I_A R_A = 500 + 40 \times ,375 = 515$$

$$515 = \frac{1200 \times 4}{2\pi \times 4} \times ,02 \times n \times \frac{2\pi}{60}$$

$$n =$$

or $E_{A1} = K\phi_1 n_1 \times \frac{2\pi}{60}$

$E_{A2} = K\phi\, n_2 \times \frac{2\pi}{60}$

بما انو التدفق ثابت $\Rightarrow$ $\frac{E_{A1}}{E_{A2}} = \frac{n_1}{n_2}$

$$\frac{480}{515} = \frac{1200}{n_2}$$

$$n_2 = 1287,5 \text{ rpm}$$

$$E_A \times I_A = T_{ind} \times W$$

$$T_{ind} = \frac{E_A \times I_A}{W}$$

or

$$T_{ind} = \frac{K\phi \cancel{W} \times I_A}{\cancel{W}} = K\phi I_A$$

4) Detrmine induced torque in Case the flux decreased to 50%, $n = 1000$ rpm, $R_{load} = 10\ \Omega$

$$E_{A1} = K\phi W = \frac{ZP}{2\pi a} * \phi \times W$$

3) Detrmine the speed rquired for the genrator to supply 20 KW, $V_T = 500V$, $\emptyset = ,02$ wb

$I = \frac{20000}{500} = 40$ A

$E_A = V_T + I_A R_A = 500 + 40 \times ,375 = 515$

$515 = \frac{1200 \times 4}{2\pi \times 4} \times ,02 \times n \times \frac{2\pi}{60}$

$n =$

or $E_{A1} = K\emptyset_1 n_1 \times \frac{2\pi}{60}$

$E_{A2} = K\emptyset n_2 \times \frac{2\pi}{60}$

بما انو التدفق ثابت

$\frac{E_{A1}}{E_{A2}} = \frac{n_1}{n_2}$

$\frac{480}{515} = \frac{1200}{n_2}$

$n_2 = 1287,5$ rpm

$E_A \times I_A = T_{ind} \times W$

$T_{ind} = \frac{E_A \times I_A}{W}$

or

$T_{ind} = \frac{K\emptyset \cancel{W} \times I_A}{\cancel{W}} = K\emptyset I_A$

4) Detrmine induced torque in Case the flux decreased to 50%, $n = 1000$ rpm, $R_{load} = 10\ \Omega$

$E_{A1} = K\emptyset W = \frac{ZP}{2\pi a} * \emptyset \times W$

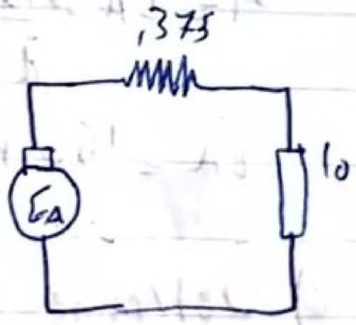
* Case 1 $E_A = 480\ V$, $\phi_1 = ,02\ wb$, $n = 1200\ rpm$
* Case 2 $E_A = ??$, $\phi_2 = \frac{1}{2}\phi_1$, $n = 1000\ rpm$

$$480 = \cancel{K} \times 1200 \times \cancel{\frac{2\pi}{60}} \times \cancel{\phi_1}$$

$$E_A = \cancel{K} \times 1000 \times \cancel{\frac{2\pi}{60}} \times \frac{1}{2}\cancel{\phi_1}$$

$$\frac{480}{E_A} = \frac{1200}{1000 \times \frac{1}{2}} \Rightarrow E_A = 200$$

$$T_{ind} = \frac{E_A \times I_A}{w} = K\phi I_A$$



$R_{eq} = 10,375\ \Omega$

$$I_A = \frac{200}{10,375} = 19,27\ A$$

$$T_{ind} = \frac{200 \times 19,27}{1000 \times \frac{2\pi}{60}}$$

Ex: DC_ generater, $Z = 640$ Condcutor, Smplex lap winding
$P = 4$, # of Coils = 80 Coil, ~~$R_A = 2{,}0$~~
$R_A = {,}25$

1) if the out put load = 3 KW, $V_T = 150$ V
Detrmine induced Voltage E_A

$$E_A = V_T + I_A R_A$$

$$I_L = I_A = \frac{3000}{150} = 20 \text{ A}$$

$$E_A = 150 + 20 \times {,}25 = 155 \text{ V}$$

2) Detrmine induced Toarque for Case(1)
if flux = ,02 Wb

$$T_{ind} = \frac{E_A \times i_A}{w} = \frac{K \theta \cancel{w} i}{\cancel{w}} = K \theta i$$

$$= \frac{ZP}{2\pi a} * \phi * i_A = \frac{640 \times 4}{2\pi \times 4} \times {,}02 * 20 = 40{,}76 \text{ N.m}$$

3) Detrmine new induced torque. if current increased 10%
flux decreased

$$40{,}7 = K * \phi * i$$

$$T_2 = K * 0{,}8 \phi * 1{,}1 i$$

$$\frac{40{,}7}{T_2} = \frac{1}{{,}8 \times 1{,}1} \Longrightarrow T_2 = 35{,}8 \text{ N, M}$$